COLORIMETRIC TEST FOR BRAKE SYSTEM CORROSION

BACKGROUND OF THE INVENTION

Description of the Related Art

Brake fluid tests have been in use for years to predict corrosion, to detect the presence of copper in the brake system, and to detect other problems with brake fluid. Most conventional brake fluid tests currently used are copper-detecting brake fluid test strips. Other conventional brake fluid testing methods utilize moisture test strips and boiling point analyzers. The main problem with conventional brake fluid tests is that they can not determine whether active corrosion of iron components is already taking place in the brake system. Although copper-detecting brake fluid test strips can accurately predict when corrosion may occur, it cannot directly measure active corrosion of iron components in the brake system.

Conventional copper-detecting brake fluid tests could benefit from another testing parameter besides copper to help determine when brake fluid can no longer perform its design function and comply with the Motorist Assurance Program (MAP) guidelines for brake fluid replacement. Part of the MAP guidelines require that brake fluid be replaced when the corrosion inhibitors are depleted and can no longer protect the brake system from corrosion.

Current technology is unable to measure the extent of iron corrosion in a vehicle to help determine if further inspection of brake system components is required, to determine whether a vehicle is a candidate for basic brake system service, or to determine if a more involved and expensive service is required. In addition, current technology is unable to estimate a risk factor associated with a vehicle brake system.

Conventional brake fluid testing methods can also be expensive. In addition, the amount of time to test and analyze the results of a conventional brake fluid testing method can be a lengthy process, requiring at least two weeks time before the results can be returned. For example, to accurately determine whether dissolved iron is present in the brake fluid in a vehicle brake system, a sample of brake fluid must be sent to a testing laboratory for inductively coupled plasma spectroscopy (ICP) testing. This type of laboratory testing is not practical for a service facility to use during regular vehicle inspection procedures. Currently, there is no calorimetric test to identify iron levels and corrosion risk in brake fluid that uses an "in the field" test to determine the corrosion level of the vehicle brake system and without having to withdraw a sample of the brake fluid and send it to a laboratory for analysis.

SUMMARY OF THE INVENTION

The invention relates to a method, apparatus and test kit for determining a concentration of iron in a brake fluid quickly and in a cost-efficient manner. Another objective of this invention is a method, apparatus and test kit for determining the level of both FE^{+2} and FE^{+3} dissolved iron ions in a hydraulic brake system.

In an embodiment of the invention, a method is provided for visually locating damaged brake system components from active iron corrosion by testing specific locations in the brake system. Another embodiment of the invention involves a method, apparatus and test kit using for visually determining the level of brake system service required and assessing a possible risk factor or risk scale for the current condition of the brake system based on a concentration of iron in a brake fluid.

The invention further provides a calorimetric test to identify iron levels and corrosion risk in brake fluid that complies with existing guideline for brake fluid replacement, such as the Motorist Assurance Program (MAP) uniform inspection and communication guidelines for brake fluid replacement, which requires brake fluid replacement when the corrosion inhibitors are depleted. Such depletion is inferable from the presence of iron ions in the brake fluid.

In its preferred embodiment, the present invention comprises a calorimetric reagent that contacts a brake fluid, resulting in a color that varies with the concentration of iron in the brake fluid. An automated embodiment of the invention includes an electronic color detector to automatically determine the results of the test by inserting the colorimetric reagent into the electronic color tester after making contact with the brake fluid to automatically determine the iron level.

BRIEF DESCRIPTION OF THE DRAWINGS

The invention will be better understood from a reading of the following detailed description taken in conjunction with the drawings in which like reference designators are used to designate like elements, and in which:

FIG. **1** shows the results tests for Iron (Fe+2 and Fe+3) concentrations in brake fluid according to the invention.

FIG. **2** is a schematic illustration of a kit embodiment of the invention.

DETAILED DESCRIPTION OF THE PREFERRED EMBODIMENTS

This invention is described in preferred embodiments in the following description with reference to the Figures, in which like numbers represent the same or similar elements.

The described features, structures, or characteristics of the invention may be combined in any suitable manner in one or more embodiments. In the following description, numerous specific details are recited to provide a thorough understanding of embodiments of the invention. One skilled in the relevant art will recognize, however, that the invention may be practiced without one or more of the specific details, or with other methods, components, materials, and so forth. In other instances, well-known structures, materials, or operations are not shown or described in detail to avoid obscuring aspects of the invention.

Applicant's invention comprises a colorimetric reagent that produces a color that varies with the concentration of iron present when said colorimetric reagent makes contact with a brake fluid. New brake fluid has relatively low iron levels, usually less than 6 ppm iron, which can slightly vary depending on the storage container the manufacturer uses. Empirical testing has demonstrated that vehicles with 50-100 parts per million (ppm) iron are experiencing the beginning of active iron corrosion, and, as those levels rise above 100 ppm, the amount of corrosion and pitting of iron component increases.

Corrosion and pitting of iron components can cause component failure and seal damage, resulting in complete or partial brake failure. Empirical testing has demonstrated that higher iron levels are found nearest the brake component experiencing active corrosion. Conventional brake fluid testing methods are not suitable for determining the amount of iron present in brake fluid when testing a vehicular brake fluid system. For example, a vehicle with a copper level above 200